CC/NUMBER 28
JULY 15, 1991

This Week's Citation Classic®

Petersen R C & Cummins K W. Leaf processing in a woodland stream. *Freshwater Biol.* 4:343-68, 1974.
[W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, MI]

The processing rate of deciduous leaf material was measured for 15 species of trees during several seasons at two sites on a small woodland stream in Michigan. Leaf processing rates were found to form a continuum from a low of 0.5 percent per day to a high of 2.0 percent per day. This suggested that, although most leaves enter a stream during a short period in the fall, their availability as a carbon source to stream heterotrophs occurs over a much longer period. [The *SCI*® indicates that this paper has been cited in more than 225 publications, making it the most-cited paper published in this journal.]

The Leaf-Stream Connection

Robert C. Petersen, Jr.
Stream and Benthic Ecology Group
University of Lund
Box 65, 221 0 Lund
Sweden
and
Kenneth W. Cummins
Department of Biological Science
University of Pittsburgh
Pittsburgh, PA 15260

In the late 1960s and early 1970s, there was considerable interest in determining what was driving ecological systems and quantifying their energetics. We and several other researchers worked in temperate deciduous forests and noticed that leaves falling into streams were consumed by aquatic organisms, becoming the main source of energy for both the microbial and invertebrate communities. In addition, terrestrial carbon, in the form of autumn shed leaves, was influencing both the species composition and the energetics of woodland streams.[1]

For some time, soil ecologists had investigated the role of autumn leaves in the ecology and energetics of soil systems. The method used was to place leaves in a mesh bag and then to measure their weight loss over time. The mesh bag tended to simulate the physical arrangement of leaves on the ground but was not appropriate for leaves in a stream. Therefore, we used leaves sewn loosely together with nylon monofilament. These we tied to a brick, giving us an experimental device similar to leaf packs found in streams. Studies conducted several years later confirmed that leaf packs did simulate leaf processing in streams better than mesh bags.[2]

In the beginning, packs were sewn together by hand, leaf by leaf, which was a time-consuming process. Later, thanks to a suggestion by colleague Boyd Hanson, we tried a device used to insert plastic tags into garments. The plastic tag was then threaded through the leaf pack in one simple movement, which bound the pack together. The pack was then fastened to an elastic band that could be slipped over the brick. During the preparation for an experiment, six or so of us sewed packs in a room filled with bricks and bags of leaves. It usually took several days to prepare for an experiment. The tedium was broken only by a noontime game of touch football. For this paper and the other experiments that led to it, we made more than 1,000 leaf packs.

For the title of the paper, we chose the word "processing" instead of "decomposition" or "mineralization," since we were measuring leaf pack weight loss and not a change in state (decomposition) or a reduction to the mineral state (mineralization). Our choice of the word "processing" has been the cause of a debate over the years that has not been totally resolved.

The work on leaf processing has been followed by many other studies that also have documented the processing rates of leaf material in streams.[3] These have led in several different directions. The leaf-pack technique can be viewed as a bioassay to study and describe the status of a human impact on stream processes.[4] The early work also led to a deeper appreciation of the connection between leaf species differences and the structure of benthic communities.[5] The linkage between riparian community structure and stream litter processing suggests that remote sensing, together with geographical information systems analysis, can be used for broad-scale analysis of land use. In fact, this is what is occurring today. In the applied area, the importance of restoring the riparian zone is viewed as the single most important measure for returning the stream to its former self-cleaning capacity.[6]

1. **Ross H H.** Stream communities and terrestrial biomes. *Arch. Hydrobiol.* 59:235-42, 1963.
2. **Cummins K W, Spengler G L, Ward G M, Speaker R M, Ovink R W & Mahan D C.** Processing of confined and naturally entrained leaf litter in a woodland stream ecosystem. *Limnol. Oceanogr.* 25:952-7, 1980.
3. **Webster J R & Benfield E F.** Vascular plant breakdown in freshwater ecosystems. *Annu. Rev. Ecol. Syst.* 17:567-94, 1986.
4. **Merritt R W, Cummins K W & Barnes J R.** Demonstration of stream watershed community processes with some simple bioassay techniques. (Resh V H & Rosenberg D M, eds.) *Innovative teaching in aquatic entomology.* Ottawa, Canada: Department of Fisheries & Oceans, 1979. p. 93-105.
5. **Cummins K W, Wilzbach M A, Gates D M, Perry J B & Taliaferro W B.** Shredders and riparian vegetation. *BioScience* 39:24-30, 1989.
6. **Petersen R C & Petersen L B-M.** A building block model for stream restoration. (Boon P, ed.) *Conservation and management of rivers.* London: Wiley. (In press.)

Received March 22, 1991